American Journal of Infection Control 44 (2016) e99-e101

Contents lists available at ScienceDirect

American Journal of Infection Control

journal homepage: www.ajicjournal.org

Brief report

Influence of pulsed-xenon ultraviolet light-based environmental disinfection on surgical site infections

Angela Catalanotti BSN, RN [a], Dudley Abbe BA [b], Sarah Simmons MPH, DrPH [c], Mark Stibich MHS, PhD [c,*]

[a] Lowell General Hospital, Lowell, MA
[b] Sodexo, Gaithersburg, MD
[c] Xenex Disinfection Services, San Antonio, TX

Key Words:
Hospital acquired infections
Noscomial infections
Environmental hygiene

This study evaluates the influence of nightly pulsed-xenon ultraviolet light disinfection and dedicated housekeeping staff on surgical site infection (SSI) rates. SSIs in class I procedures were reduced by 46% ($P = .0496$), with a potential cost savings of $478,055. SSIs in class II procedures increased by 22.9%, but this was not significant ($P = .6973$). Based on these results, it appears that the intervention reduces SSI rates in clean (class I), but not clean-contaminated (class II) procedures.

Evidence exists that operating rooms (ORs) may remain contaminated after standard disinfection practices. Approximately 50% of surfaces are not adequately disinfected during between-case or terminal cleaning, and can harbor pathogenic organisms such as *Pseudomonas* spp, *Acinetobacter* spp, and *Klebsiella* spp.[1,2] If these surfaces are not appropriately disinfected, the residual pathogens can cause the environmental surfaces to be a reservoir for pathogens.[3] We sought to determine whether increased environmental disinfection in the OR would have an influence on surgical site infection (SSI) rates.

Recent advances in environmental disinfection have yielded "no touch" disinfection systems that use ultraviolet (UV) light to reduce residual microbial contamination in patient environments after manual cleaning. We investigated the use of pulsed-xenon UV (PX-UV) (Xenex Disinfection Services, San Antonio, TX). The PX-UV system uses intense, broad-spectrum pulses of germicidal UV to disinfect surfaces.[4] The use of PX-UV disinfection has been reported to have reduced the hospital-acquired infection rates of *Clostridium difficile*, methicillin-resistant *Staphylococcus aureus*, and multidrug-resistant organisms within the acute care setting by 57%, 53%, and 20%, respectively.[5] Recent international OR consensus guidelines suggest that the use of portable UV disinfection systems should be considered as an adjunct to traditional cleaning practices.[6] New research has demonstrated that incorporating UV into a bundled approach to preventing SSIs has been effective in reducing orthopedic SSI rates.[7]

The influence of UV disinfection on SSIs is likely to be correlated with the characteristics of the surgical case, primarily the prior contamination risk associated with the procedure.[8] A measure for this contamination risk is the wound classification assigned postoperatively. Surgical wounds are divided into 4 classes: I = clean, II = clean-contaminated, III = contaminated, and IV = dirty-infected. The influence of UV disinfection would be expected to decrease as wound class increases, due to the pre-existing intrinsic contamination present during surgery. To control for the influence of wound class, the data were stratified in this study by wound class before analysis.

METHODS

This study was conducted at an independent, not-for-profit community hospital in the northeastern United States that has more than 200 beds and 13 ORs. Institutional review board exemption was obtained. The analysis compares a baseline period that involved standard terminal cleaning and disinfection of the ORs to an intervention period during which an enhanced disinfection method using a PX-UV room disinfection system as well as dedicated personnel for terminal cleaning was implemented.

During the baseline period (January 2012-March 2013), OR staff performed thorough terminal disinfection of the ORs nightly as well as standard between-case cleaning. The OR staff received on-the-job training regarding appropriate techniques for disinfection of the

* Address correspondence to Mark Stibich, PhD, Xenex Disinfection Services, 121 Interpark, Suite 104, San Antonio, TX 78216.
E-mail address: Stibich@gmail.com (M. Stibich).

Conflicts of Interest: DA is an employee of Sodexo. SS and MS are employees and shareholders in Xenex Disinfection Services.

http://dx.doi.org/10.1016/j.ajic.2015.12.018

ORs. Staff members were responsible for cleaning all surfaces and equipment within the OR.

During the intervention period (April 2013-December 2014), the between-case cleaning continued to be performed by the OR staff. However, the terminal cleaning process was performed by a dedicated housekeeper, and was augmented by the addition of PX-UV disinfection. After standard manual chemical clean, 2 PX-UV disinfection systems were placed in proximity to high-touch surfaces, such as the operating table, anesthesia machine, medication cart, and electrocautery control unit. All exposed surfaces in the OR received PX-UV disinfection. The room is not occupied while systems are operating. The 2 systems disinfected simultaneously for a 10-minute cycle. This is longer than the 5-minute cycle typically employed for PX-UV systems used in patient rooms due to the larger square footage of an OR. All ORs were given this treatment on a nightly basis. No PX-UV disinfection was performed between cases. No additional programs aimed at reducing SSIs were implemented during this intervention.

The sample included all class I and class II SSIs from January 2012 through December 2014. The preintervention sampling period was limited to 15 months due to changes in the surveillance definitions used for SSIs before January 2012. Trained infection preventionists tracked patients for signs and symptoms of SSI during their hospital stay and after discharge using the National Healthcare Safety Network definitions. Procedures were stratified by wound class into class I procedures or class II procedures. Class III and higher wound procedures are not included in the routine surveillance at the hospital. Wound class was documented by the surgeon after completion of the procedure. Infection rates were compared using a 1-sided Student *t* test.

RESULTS

Class I procedures

Six thousand four hundred thirty-nine class I procedures were performed during the baseline period. Thirty-one SSIs occurred, for a rate of 0.48 per 100 cases. Ten thousand eight hundred eighty-three procedures were performed during the intervention period. Twenty-nine infections occurred, for a rate of 0.26 per 100 cases. This represents a 44.6% decrease in the infection rate ($P = .0496$), see Table 1. Based on the infection rate from the baseline period, a total of 52 class I SSIs would have been expected during the intervention period. Only 29 infections occurred, indicating that 23 potential infections were prevented. A timeline for class I infection rates is provided in Figure 1.

Class II procedures

Four thousand eight hundred eleven class II procedures were performed during the baseline period and 13 infections occurred, for an infection rate of 0.27 per 100 cases. In the intervention period, 7,825 procedures were performed and 26 infections occurred for an infection rate of 0.33 per 100 cases. This represents a 22.9% increase in infection rates. However, this change was not statistically significant ($P = .6973$) (see Table 1).

DISCUSSION

The results show a significant reduction SSI rates for class I procedures during the intervention period. The success of the integration

Table 1
Comparison of baseline and intervention (nightly pulsed xenon ultraviolet light disinfection) surgical site infections (SSIs)

	Baseline			Intervention				
Type	SSIs	Procedures	Rate*	SSIs	Procedures	Rate*	% change	*P* value
Class 1	31	6,439	0.48	29	10,883	0.26	–44.6%	.0496
Class 2	13	4,811	0.26	26	7,825	0.33	+22.9%	.6973

*Rate per 100 procedures.

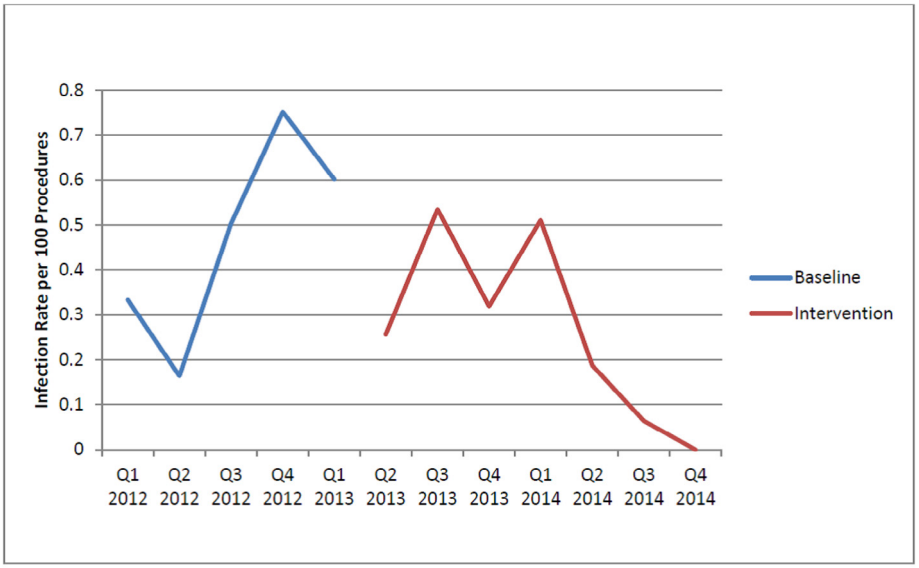

Fig 1. Rate of class 1 surgical site infections by quarter (Q), January 2012-December 2014.

of PX-UV systems and dedicated staff into cleaning and disinfection protocols demonstrates there is a likely link between surface disinfection and SSI rates for class I procedures. Using $20,785 as the average additional cost per infection,[9] and a mortality rate of 3% for SSI,[10] this intervention may have saved $478,055 and 1 life.

Infection rates for class II procedures did not change during the intervention period. The microbial load at the surgical site is greater for class II wounds, and it would be anticipated that the influence of environmental disinfection would be less meaningful than for procedures with a clean incision.

References

1. Munoz-Price LS, Birnbach DJ, Lubarsky DA, Arheart KL, Fajardo-Aquino Y, Rosalsky M, et al. Decreasing operating room environmental pathogen contamination through improved cleaning practice. Infect Control Hosp Epidemiol 2012;33:897-904.
2. Carling PC, Briggs JL, Perkins J, Highlander D. Improved cleaning of patient rooms using a new targeting method. Clin Infect Dis 2006;42:385-8.
3. Loftus RW, Koff MD, Burchman CC, Schwartzman JD, Thorum V, Read ME, et al. Transmission of pathogenic bacterial organisms in the anesthesia work area. Anesthesiology 2008;109:399-407.
4. Jinadatha C, Quezada R, Huber TW, Williams JB, Zeber JE, Copeland LA. Evaluation of a pulsed-xenon ultraviolet room disinfection device for impact on contamination levels of methicillin-resistant *Staphylococcus aureus*. BMC Infect Dis 2014;14:187.
5. Chemaly RF, Simmons S, Dale C, Ghantoji SS, Rodriguez M, Gubb J, et al. The role of the healthcare environment in the spread of multidrug-resistant organisms: update on current best practices for containment. Ther Adv Infect Dis 2014;2:79-90.
6. Alijanipour P, Karam J, Llinas A, Vince KG, Zalavras C, Austin M, et al. Operative environment. J Orthop Res 2014;32(Suppl 1):S60-80.
7. Fornwalt L, Ennis D, Stibich M. Impact of total joint infection control bundle on surgical site infection rates. Am J Infect Control 2016;44:239-41.
8. Woodfield JC, Beshay NM, Pettigrew RA, Plank LD, van Rij AM. American Society of Anesthesiologists classification of physical status as a predictor of wound infection. ANZ J Surg 2007;77:738-41.
9. Scott RD, Douglas R. The direct medical costs of healthcare-associated infections in US hospitals and the benefits of prevention. 2009.
10. Awad SS. Adherence to surgical care improvement project measures and post-operative surgical site infections. Surg Infect (Larchmt) 2012;13:234-7.